16 MAY 1914
ENTOM.

Horticultural Experiments at Southern Pines, 1895

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

BULLETIN NO. 129

JULY 10, 1896

446

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA
AGRICULTURAL EXPERIMENT STATION,

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

N. C. STATE BOARD OF AGRICULTURE.

W. F. GREEN, *Chairman*, Franklinton.

W. S. PRIMROSE.....Raleigh.	J. H. GILMER.....Greensboro.
D. A. TOMPKINS.....Charlotte.	J. R. MCLELLAND.....Mooresville.
H. E. FRIES.....Salem.	CYRUS THOMPSON.....Richlands.
N. B. BROUGHTON.....Raleigh.	H. E. KING.....Peanut.
R. W. WHARTON.....Washington	E. A. AIKEN.....Jeptha.
J. B. COFFIELD.....Everett's.	J. L. NELSON.....Lenoir.
W. R. CAPEHART.....Avoca.	FRANK WOOD.....Edenton.

STAFF OF THE EXPERIMENT STATION.

H. B. BATTLE, PH. D.....Director and State Chemist
F. E. EMERY, M. S.....Agriculturist.
GERALD MCCARTHY, B. SC.....Botanist and Entomologist.
W. F. MASSEY, C. E.....Horticulturist.
C. F. VON HERRMANN (U. S. Weather Bureau).....Meteorologist.
F. E. HEGE.....Poultry Manager.
F. P. WILLIAMSON, D. V. S.....Consulting Veterinarian.
B. W. KILGORE, M. S.....Assistant Chemist.
W. M. ALLEN.....Assistant Chemist.
C. B. WILLIAMS, B. S.....Assistant Chemist.
H. K. MILLER, M. S.....Assistant Chemist.
S. E. ASBURY, B. S.....Assistant Chemist.
ALEXANDER RHODES.....Assistant Horticulturist.
ROSCOE NUNN (U. S. Weather Bureau).....Assistant Meteorologist.
A. F. BOWEN.....Secretary.

RALEIGH, N. C.

PREFACE.

Mention has previously been made of the horticultural experiments which are being conducted by the North Carolina State Horticultural Society in co-operation with the North Carolina Agricultural Experiment Station and the German Kali Works at Southern Pines, in the pine-belt region of the State, sixty-six miles southwest of Raleigh.

The work for the present consists mainly in fertilizer tests, and is conducted on such a scale and in such a manner that the results will undoubtedly prove of great value to horticulturists in general, located not only in North Carolina, but throughout the United States and probably abroad. The line of work undertaken is in the solution of the question, "What amount of phosphoric acid, nitrogen and potash is needed for the best development of horticultural products?" For this purpose no mixed commercial fertilizers are used, but the fertilizing ingredients themselves, in various proportions and combinations, are employed.

Believing a solution of these questions will be most valuable accessions to agricultural and horticultural knowledge, the Station consented to co-operate in the investigations, and for the same reason now reprints (with the permission of the Supervising Committee) the first annual report of the work, as one of its bulletins.

H. B. BATTLE, *Director.*

TABLE OF CONTENTS.

HORTICULTURAL EXPERIMENTS AT SOUTHERN PINES, DURING 1895. PAGE.

Introduction 161
Location of the experiments 165
Geology of the region 167
Geological notes of the Southern Pines region 167
Climatic conditions 169
Sketch of the climate of Southern Pines and vicinity 169
The soil and its comparative composition 172
Chemical analyses 173
Mechanical analyses 174
The plan of the experimental tests 174
Clearing the land and preparation for planting 177
Varieties of fruit selected, and general treatment 178
Laying out plats, setting plants, and subsequent cultivation 180
Details of fertilizing 183
Methods of recording growth, making notes, and securing photographic records 188
Weather conditions during 1895 189
Fungous and insect enemies and their treatment 190
Difficulties encountered during the first year 191
Growth during 1895, and conclusions 192

HORTICULTURAL EXPERIMENTS DURING 1895, AT SOUTHERN PINES, N. C.

[Reprinted from the First Annual Report of the Experimental Farm of the N. C. State Horticultural Society, prepared by the Supervising Committee.]

I. INTRODUCTION.

The Experimental Farm of the N. C. State Horticultural Society is situated in Moore County, 66 miles southwest of Raleigh, on the Seaboard Air Line, near the corporate limits of the town of Southern Pines, a place which has assumed considerable prominence as a health resort. This portion of the State was formerly covered by a heavy growth of long-leaf pine (*Pinus australis*, Mx, *P. palustris Mill*), the merchantable trees of which have now been largely consumed by the lumber industry. The soil is a very deep sand, containing but little clay, humus or vegetable matter, other than the wire-grass and the roots of the pines and scrub oaks (*Quercus Catesbæi*), which now, or recently, covered the soil. In addition to the last named, another post oak (*Q. falcate*) is found, also the black jack oak (*Q. nigra*). The herbaceous growth is chiefly wire-grass (*Aristia stricta, Mx.*), blue lupin (*Lupinus diffusus, Nutt*), and false indigo (*Baptisia villosa, Ell.*), and different leguminous and orchidaceous plants of less importance. The latitude of Southern Pines is 35° 31′ N.; longitude 79° 2′ W. (Greenwich). The altitude averages 400 feet above sea level. The Experimental Farm occupies two plots located north of Southern Pines, including, in the aggregate, about 120 acres.

The practical value of field experiments, conducted under competent supervision and by rigidly exact methods, is now too well understood to require explanation, and need not be here elaborated.

The policy of the N. C. State Horticultural Society from its foundtion in 1879, has been to foster and develop by every available means the immense latent horticultural resources of the State. The decade from 1885 to 1895 has witnessed a most wonderful growth in the trucking and grape growing industries. More recently, parties have begun growing peaches and plums with the most gratifying success wherever the soil has been found suitable for this class of fruit. As notable examples occurring in Moore county, near Southern Pines, may be cited the Van Lindley peach orchard of nearly 500 acres, (Fig. 1) and the Niagara Vineyard Company, of 250 acres in grapes, (Fig. 2). In North Carolina there are hundreds of thousands of acres of sandy lands formerly covered with heavy pine timber, which has fallen before the axe of the lumberman. Besides this area of

sandy soil, there are at least as much more of loamy upland which has heretofore been cropped chiefly in cotton and corn, but which, owing to the present low prices of these staples, have ceased to be as profitable to their owners as formerly. What to do with these light lands is a problem of capital importance to our State and the cotton belt generally. They are usually too light or too dry to be laid down in permanent grass; and stable manure, the great stand by of agriculture in grazing districts, is not to be had in sufficient quantity for general use. Commercial fertilizers are the only practicable form of manure for these lands, but these, in the main, are too expensive for staple crops upon this class of soils, while crops sell at present prices.

To see these now unproductive lands transformed into fruitful orchards and vineyards, has been the desire of the State Hor-

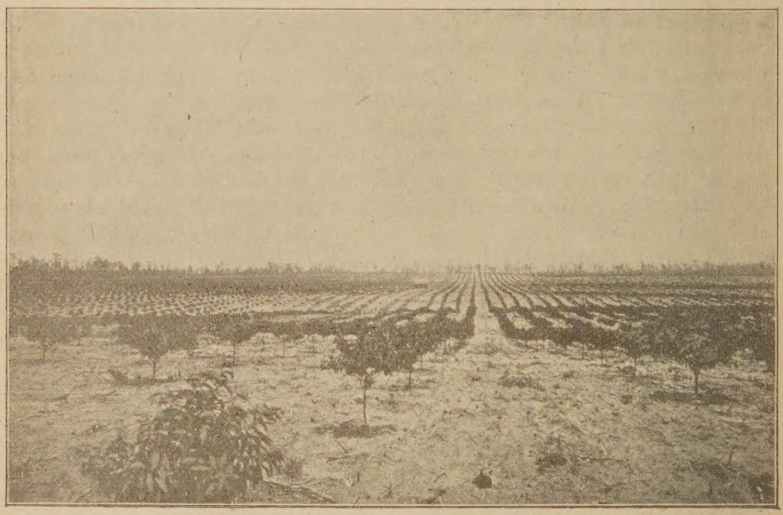

Fig. 1.—Peach orchard of the Van Lindley Orchard Co. (500 acres) near the Experimental Farm.

ticultural Society. In order to embody its views in practical form and furnish an object lesson in improving such lands, the Society has long sought the establishment of an experimental fruit and vegetable farm upon a typical light soil, whereon might practically be determined upon a commercial scale whether or not these lands, when aided by the most advanced scientific ideas of fertilization and improved methods, could be successfully cultivated in fruit and truck crops. In carrying out its plans, the Society has availed itself of an offer made by the German Kali Works to donate a certain sum for the purpose of assisting the experiments.

To assure scientific and accurate methods and authoritative results, the Society sought and obtained the active co-operation of the North

Carolina Agricultural Experiment Station. In co-operating in these investigations, the Station furnishes the expert work relating to horticultural, botanical, entomological, and chemical subjects, and sustains all the necessary expenses in connection with this co-operation. This involves detailed and painstaking labor in every step of the work, some of which are described in the following pages.

It is generally understood that the German Kali Works control the principal source of potash of commercial importance known to the world. Potash is one of the three principal fertilizing ingredients required by all crops for their full development, and every brand of complete commercial fertilizer must contain it in some form. Inasmuch as these Works must be benefited by the successful outcome of the experiments, it would seem proper that they should assist in bearing some of the expenses incident thereto.

Fig. 2.—Vineyard of the Niagara Co. (250 acres) near Southern Pines, N. C.

A summary of the articles of agreement adopted by the parties co-operating in conducting the experimental work, will not be out of place and are given herewith.

The object of the work is to determine the proportion of the different fertilizing ingredients necessary for the best growth and development of orchard and garden fruits and other horticultural and agricultural products, and the best treatment of the soil to produce this result. No commercial brand of fertilizer is used, but fertilizing ingredients are employed in various combinations. The locality of this work is known as the Experimental Farm of the North Carolina State Horticultural Society, and is under the control of a Super-

vising Committee composed of representatives ot the Society, the Experiment Station, and the Kali Works. Reports of progress are published annually, or oftener if necessary, and these reports can be republished, either in whole or in part, by either of the institutions. The latter are prevented from issuing any other report of the work, or of any results that are reached, except as are contained in these reports.

The entire conduct of the work is thus intrusted to the Supervising Committee composed of six members, of which three are appointed by the Horticultural Society, two by the Experiment Station, and one by the German Kali Works. The following is the present (1896) constitution of the Committee:

On behalf of the Horticultural Society:
J. Van Lindley, President N. C. State Horticultural Society.
C. D. Tarbell, Member Executive Committee of the Society,
Gerald McCarthy, Secretary of the Society.

On behalf of the Experiment Station:
H. B. Battle, Director N. C. Agricultural Experiment Station.
W. F. Massey, Horticulturist of the Station.

On behalf of the German Kali Works:
B. von Herff.

The Supervising Committee has been organized as follows:
H. B. Battle, Chairman.
Gerald McCarthy, Secretary.
C. D. Tarbell, Resident Member at Southern Pines.

The local superintendent is D. D. F. Cameron.

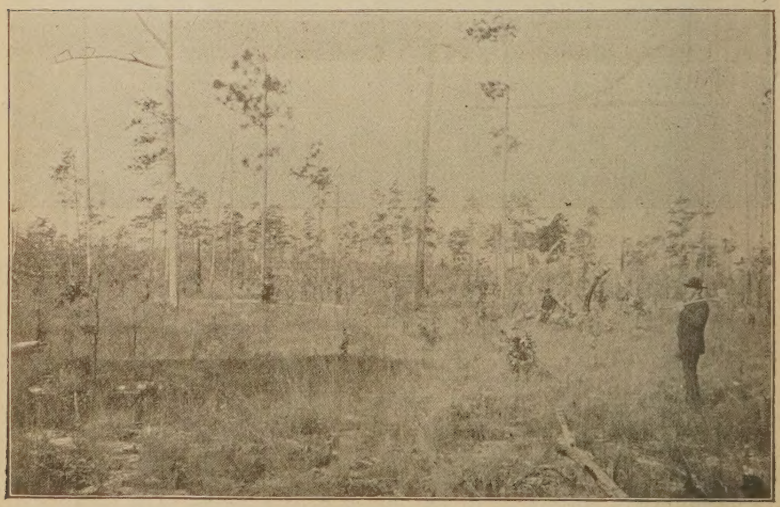

Fig. 3.—Appearance of the Experimental Farm (fruit department) on February 12, 1895, before the work of clearing was commenced.

2. LOCATION OF THE EXPERIMENTS.

Moore County, N. C., was selected as the location of the experimental farm, because it is the center of a large and rapidly developing fruit district, embracing already many hundreds of acres in grapes, peaches, blackberries, and other fruits. The soil has proven to be well adapted to the growth of these fruits, and is as uniform and level as is possible to secure for the extensive field experiments which were designed. The soil here found represents vast bodies of land originally

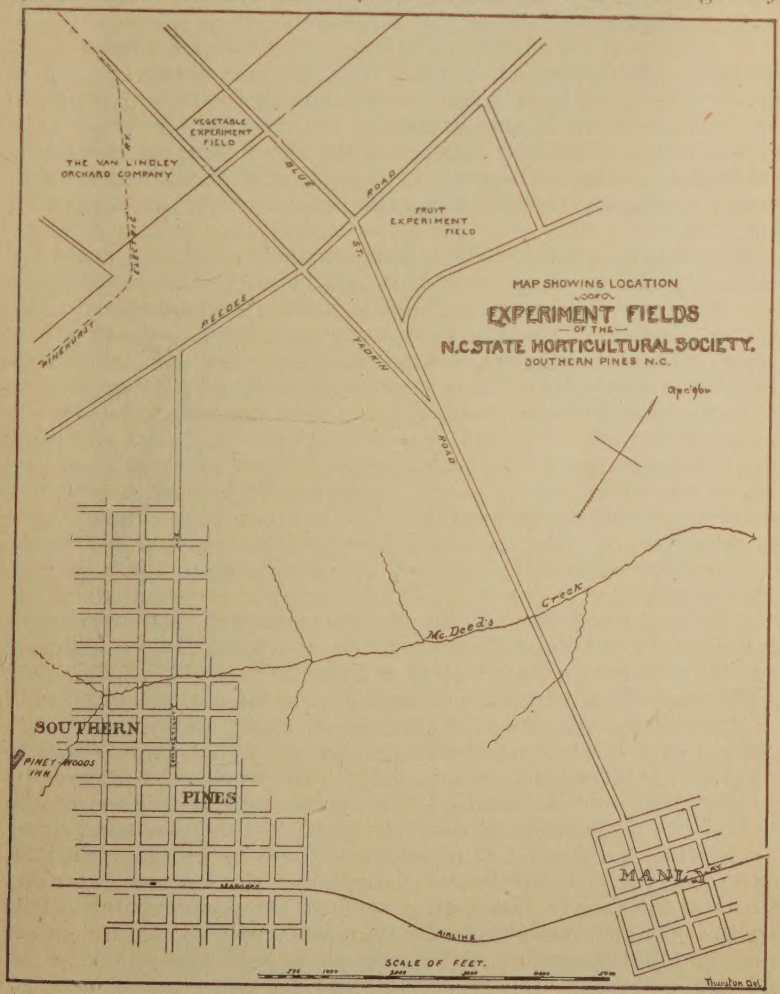

Fig. 4.—Sketch map showing location of the fruit and vegetable department of the Experimental Farm.

in long-leaf pine, but now partially covered with a growth of smaller pines, oaks, and dogwood. The original pines of merchantable size have long since been cut and sawed by the insatiate lumberman. These bodies of pine lands, which are well illustrated by Fig. 3, cover the adjacent counties, and stretch easterly, northerly, and southerly, extending southward through South Carolina and Georgia. The illustration is reproduced from a photograph of the exact location of the fruit field of the Experimental Farm as it appeared on February 12, 1895, a few days before the work of clearing was commenced.

On account of the equable climate, good natural drainage, and the beneficial effect of the air surrounding the pine woods, this region has become noted for its health resorts, among them being Southern Pines, Pine Bluff, Aberdeen, Manly, and the more recently built model town of Pinehurst. This fact also was of moment in deciding the Society to locate the work here, because it furnished an additional means for disseminating the results of the work to other localities.

The location chosen for the fruit department of the experimental farm (Fig. 4) lies immediately north of the town of Southern Pines, and about one mile from its corporate limits. It is situated directly at the juncture of the Pee Dee Avenue and Blue Avenue, both of which traverse the county, and are important thoroughfares. The location is admirable; it furnishes a body of land sixty-five acres in extent, almost entirely level, and in every way well suited for the purposes in view. The land was in its virgin condition, excepting that the heaviest pines had been cut for lumber, and that forest fires which occasionally swept over it had generally burned the dry wire grass and dead underbrush, but had not otherwise damaged the growth upon it. The use of land which had not been previously fertilized or cultivated in any crop is of great importance in such an experiment.

Another tract of fifty acres, about one-fourth mile southwest of this location, was subsequently secured for the purpose of conducting similar field tests upon different varieties of vegetables. This tract was not ready for experimental tests during the year 1895, and need not further be mentioned in this report, except to say that it was cleared in the same manner in the spring of that year, as will be described in detail in treating of the fruit tract. Cowpeas of the "Unknown" or "Wonderful" variety were sown broadcast at the rate of one and one-fourth bushels per acre without any fertilizing application. The growth of vines proved to be fair but not luxuriant, which was due to the freshness of the land. But few seeds were matured, as the variety, late sowing, and bad seasons prevented. This leguminous crop was planted for the purpose of plowing under during the following winter and spring as an easy plan to utilize the nitrogen-gathering property of this valuable Southern field crop, for the benefit of the vegetable crops to follow it as well as to pre-

vent the spontaneous weed growth upon the newly cleared land, to improve its mechanical condition, and to add organic matter to the soil.

3. GEOLOGY OF THE REGION.

At the request of the Committee, the State Geologist, Prof. J. A. Holmes, has kindly furnished the following geological notes, descriptive of the region:

Geological Notes of the Southern Pines Region.

The vineyards and orchards about Southern Pines occupy the divide between the tributaries of the Great Pee Dee River, as represented by the headwaters of Lumber River on the South, and the Cape Fear as represented by the headwaters of Lower Little River on the North. This divide represents the typical sandhill country of the Carolinas. Its topography is decidedly pronounced, its highest portions having an elevation of from 400 to nearly 600 feet above the sea, while the brooks and creeks in the vicinity run at an elevation 100 to 200 feet lower; and the bordering rivers have an elevation of some 100 feet above tide water.

The soil is everywhere sandy—whether about the tops of the hills or the lower ravines, and this sand has been found in places to extend to a depth of some 200 feet. The hilliness of the surface and the prevalence of the sand have given rise to the use of the terms "sandhills" or "sandhill" region.

The geological formations of the Southern Pines region may be briefly described, as follows:

(1.) The most widespread and characteristic formation of the region is the great layer of medium to coarse grain sands, having an aggregate thickness of probably 300 feet. This rests below directly upon the top of the old crystalline rock, and they appear at the surface over a large part of the area about Southern Pines, rising to near the tops of the higher hills. This material belongs to what has been designated the *Potomac* formation, so named because it was first carefully described from its occurrence about the Potomac River in the vicinity of Washington. These deposits, as they occur in the vicinity of Southern Pines, are by no means (as they might seem) composed of pure sand; but everywhere this sand has mingled with it more or less finely divided particles of clay and loam, which, along with the sand, have been washed down from the western highlands; and to this is due whatever of fertility the soils of the region possess.

In addition to these disseminated particles of clay and loam, there are also to be found at different depths below the surface irregular layers of clay and loam, some of which may be seen at places in the railroad cuts, and there are occasionally thin deposits of lignitic material, the most notable of which outcrops at the surface some two or three miles southeast of Southern Pines. These extensive beds of

sand constitute large reservoirs for the storage of water, from which underground supplies move southeastward toward the coast, which may be tapped about Fayetteville, Wilmington, and other eastern towns, and from these sands considerable supplies of water may be brought to the surface by sinking wells to depths of from 100 to 300 feet, and using deep well pumps.

This Potomac formation extends westward from Southern Pines until it comes against the red sandstone and hard crystalline rocks at a distance of from ten to twenty miles. It extends eastward, appearing near or at the surface throughout the sandhill region, and further eastward is buried beneath the later geological formations.

(2.) Near the tops of some of the higher hills may be found the remnants of another geologic formation—the *Eocene*—quite different in character from that just described. This formation, though at one time no doubt it extended over a large area in all directions, is now found in this region only in isolated patches. The best exposure of it near Southern Pines can be found at what is termed locally the "Paint Hills," or "Paint Beds," one and a-half to two miles southeast of the railway station. As it occurs here and elsewhere, it is a light yellowish or buff tinted, somewhat porous but fine grained, silicious material, and contains a limited variety of the older Eocene fossils.

This formation also occurs more extensively near the tops of the higher sandhills in the neighborhood of Spout Springs, from which latter region samples have been tested and are found to make excellent fire-brick.

(3.) Still another geologic formation—one that has been designated the *Lafayette*—which is composed of light colored loams and brown and orange colored sands (stained with iron), is found overlying the above-described Eocene remnants at the tops of the higher hills, on the slopes of the region, and also in the lowlands.

Long after the Eocene and Potomac formations had been deposited beneath the ocean border, in more or less horizontal layers, over extended areas, the surface of the country was lifted above the sea to an elevation, perhaps, fully as great as that of the present time. The agencies of erosion gradually removed from the surface the larger part of the Eocene and a very considerable portion of the Potomac formations, and the surface of the country assumed much the same hilly appearance which it now has. While in this condition, this entire region, along with all of Eastern North Carolina and the South Atlantic and Gulf slopes, was again submerged beneath the ocean, and another geological deposit, the Lafayette, just described, was laid down over the surface, covering hill and valley alike. And after this had taken place, the surface of this region was again lifted to something like its present elevation, and probably has not been completely submerged since. But since then the work of erosion has been again in progress, and a large portion of the Lafayette materials, then deposited, have been subsequently washed down into the streams and

carried to the sea; and during later time the action of the winds and rains have, in many places, served to rearrange, and mingle more or less along the valleys and ravines and slopes, the sands and clays and loams which belonged originally to these several geologic formations. So that it is true of such places at the present time—as is the case with much of the surface material about the town of Southern Pines—that the soil materials which we find exposed at the surface, instead of belonging to some one distinctive formation, is the result of subsequent rearrangement and intermingling of the materials from two or more such formations.

4. CLIMATIC CONDITIONS.

In order to present a concise statement of the climatic conditions of the regions where the experiments are being conducted, the following sketch is included, which was prepared by C. F. von Herrmann, Assistant Director of the North Carolina Climate and Crop Service.

Sketch of the Climate of Southern Pines and the Vicinity.

The available meteorological records for the Southern Pines section are very few. There are only three places in Moore County for which a few records of temperature and precipitation exist, namely, Manly, one year and three months (1881, 1883), Carthage, two years and seven months (1880, 1882), and at Southern Pines itself observations have been continued, with frequent interruptions, only since January, 1889. It has been thought advisable, therefore, to determine the normal climatic elements for the entire section by combining records for longer series of years, which are available for ten stations immediately surrounding Moore County.

This county occupies the southern portion of the Central District of North Carolina, and has both a higher temperature and greater rainfall than the mean of its district. Transferred eastward to the meridian of Paris it would occupy the position of northern Algiers, that is 13 degrees of latitude south of the best vine-growing region of France, which extends from the mouth of the Loire northeast to Mezieres, near the Belgian frontier.

Temperature is the most important of the climatic elements in its influence on the vital processes of plants, which cease above or below certain limits. The following table gives the normal mean temperature for each month of the year, together with the possible extremes, as determined from observations covering a period of ten years:

Normal Temperature and Possible Extremes for Moore County, N. C.

Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Normal	42	46	50	61	69	76	79	76	70	59	51	45
Possible maximum	80	80	91	97	98	103	103	100	103	90	80	75
Possible minimum	8	5	21	28	38	48	50	52	44	30	16	7

The annual mean temperature for the county is over 60 degrees,

with spring and autumn means also 60, summer 77, and winter 44 degrees. Southern Pines itself will be slightly warmer. Noteworthy is the fact that all of these temperatures are much higher than the corresponding means for the region of France referred to, which are: spring about 50, summer 64, fall 51, and winter 38.

The warmest month at Southern Pines is July, when the mean approaches 80 degrees, and the coldest is January, with a normal mean of 42. During the remarkably cold winter of 1895 the mean for January was 34, for February 35 degrees.

The vine requires a high summer temperature, with an early and prolonged period in which to ripen its fruit, and the advantages of the Southern Pines section in this respect is quite evident, since the mean remains above 70 degrees from June until as late as September. The extremes given in the above table are, of course, taken from records of unusual warmth or cold, and do not express what may usually be expected. Such minimum temperatures as occurred January 7th, 1895, (8°), and February 5th, 1895, (5°), can only happen during such exceptionally cold winters as that of 1895. The formation of ice, due to the freezing of sappy plants, does not begin at 32 degrees, but much lower, for the reason that the sap is not pure water, and is contained in the capillary portions of the vegetable structure. During the period of rest in winter, when the sap no longer flows, all the fruits possible of cultivation in Moore County certainly could not suffer from the cold of a normal winter.

On the other hand, the effect of high temperatures can only be injurious in conjunction with periods of drought; or, what is more serious, if a very warm period occurs so early in the season as to force vegetation prematurely and render it more likely to be killed by subsequent frosts. A well-remembered instance of the kind happened in March, 1894, during which nearly all varieties of fruit trees bloomed nearly three weeks in advance of the season, only to be subsequently killed at the end of the month by temperatures below freezing. Fortunately such phenomena are exceptionally rare.

The possibility of growing fruits successfully in any locality depends more on the dates of late spring and early autumn frosts than on winter temperatures. The following table gives the temperatures at which some of the more common fruits are liable to receive injury from frost while in active growth, (Weather Bureau Bulletin, No. 86):

Plant.	In Bud.	In Blossom.	In Setting Fruit.	At Other Times During Growing Season.
Apples	27	29	30	26
Grapes	31	31	30	28
Peaches	29	30	30	29
Pears	28	29	29	28
Plums	30	31	31	29
Strawberries	28	28	28	30
Tomatoes	31	31	31	31

The last killing frost in spring (temperature of 32) will generally

occur before April 10th, though frost has occurred as late as May 6th (1891) with a minimum temperature, however, of only 38. Observations must determine which fruits or varieties have a tendency to bloom before this date (April 10th), and are therefore liable to damage by frosts. In fall, the first killing frost will usually not occur before October 20th.

The amount of moisture required for horticultural crops varies greatly, according to the kind of plant, the season, the supply of heat and light, and numerous other considerations. Vegetation at all times exudes moisture through the foliage, and the supply must be kept up by absorption through the roots. The nature of the soil is of much importance, for it must not be so coarse as to retain too little water during hot spells, which are liable to occur. Light, sandy soils maintain on an average from 5 to 10 per cent. of water, hence a larger supply is required for such soils. This is furnished by the relatively large amount of precipitation which falls in the Southern Pines section, as presented in the following table, together with the average number of rainy days:

NORMAL PRECIPITATION AND NUMBER OF RAINY DAYS FOR THE SOUTHERN PINES SECTION.

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Normal precipitation	4.70	4.03	4.34	3.14	4.72	4.30	6.44	6.41	3.46	3.36	2.83	3.03
No. of rainy days	12	10	11	9	10	10	12	12	8	7	7	8

These figures are not as exact as those for temperature, and at Southern Pines itself the precipitation will be found appreciably higher, since the northwestern portion of Moore county is drier than the southeastern. It is found that the amount of moisture is very well distributed over the seasons, the soil receiving annually about 51 inches. Of this amount approximately 40 per cent. will be carried off by the streams, and the remainder is effective in raising the level of the ground water from which the upper soil is supplied by capillary attraction.

The largest amount of rain falls in July and August, each with a normal of over 6 inches; the least amount falls during the last four months of the year, when the moisture is no longer so essential, but bright sunshiny days are required. There is, however, a distinct minimum in April, which is usually dry, and a secondary minimum in June. A period of drought may occur in any month. The rains of this section generally occur with local storms, which are most frequent in July and August, giving these months the largest number of rainy days. Amounts of rainfall exceeding 10 inches per month, have occurred in May, July, and August at Southern Pines, namely: 11.08 in May, 1891; 10.83 July, 1892, and 10.58 August, 1891, but there is no record of less than 1.00 inch per month. The amount of snowfall in winter is small, and, what does fall, rarely remains on the ground more than an average of two days. On the

whole with respect to precipitation, this section may be considered well adapted to the purposes of horticulture, though the amount furnished seems to be in excess of the requirements of crops, if compared with the amount received in that region of France so favorable for the growth of the vine, where the total annual rainfall is less than 25 inches.

The prevailing winds over Moore county are more nearly south than southwest during the season of growth, with a velocity rarely reaching injurious force, except during the passage of sub-tropical storms, which sometimes occur in August, September, and October. The average annual cloudiness will be found to be somewhat less than 50 per cent., but higher in January and August than during the remaining months of the year. The normal number of clear days is 125, partly cloudy 130, and cloudy 110. The amount of sunshine is amply sufficient.

5. THE SOIL AND ITS COMPARATIVE COMPOSITION.

The character of the soil, as heretofore mentioned, is sandy, with a sandy subsoil to an uncertain depth. The examination of the soil, to determine more accurately its composition, included both chemical and mechanical analyses. The samples were taken by inserting into the soil a two-inch wrought-iron pipe bevelled to a sharp edge. The first six inches thus taken was designated the *top soil*, and the twelve inches immediately underneath, that is from six to eighteen inches below the surface, was called the *sub-soil*. The samples taken in this way were partially dried in the sun, then transferred to the laboratory and completely air dried in the shade.

A series of samples were taken in the north and south roadway, in the fruit tract, after the field had been laid out and planted. Six portions (top soil and sub-soil) were sampled at distances about 300 feet apart and carefully mixed. In the analyses below, No. 94 represents the composite sample of the top soil taken as above described, while No. 95 represents the sub-soil of the same composite samples. The chemical analyses were made according to the method of the Official Agricultural Chemists for 1895. In the top soil the proportion of coarse particles and fine earth was 14.63 and 85.37 respectively, while in the sub soil the coarse particles had decreased to 11.80 per cent., the fine earth being 89.20 per cent. In the analyses the fine earth only was treated with hydrochloric acid. The result was as follows:

CHEMICAL ANALYSES OF THE TOP SOIL AND THE SUB-SOIL OF THE FRUIT FARM.

	Top Soil (6 inches deep). No. 94.	Sub-soil (6-18 in. deep). No. 95.
Moisture	.420	.205
Insoluble matter	96.010	97.390
Phosphoric acid	.037	.026
Volatile and organic matter (containing nitrogen .140)	2.025	(containing nitrogen .014) 1.123
Lime	.040	.035
Sulphuric acid	.036	.041
Soluble silica	.089	.062
Magnesia	.040	.045
Oxides of iron and alumina	.818	1.058
Potash	.027	.035
Soda	.113	.107
	99.625	99.995
Coarse particles	14.63	11.80
Fine earth	85.37	89.20

The following mechanical analyses were made by Prof. Milton Whitney, Chief of the Division of Agricultural Soils, U. S. Department of Agriculture, who characterizes the samples as "very uniform in their mechanical texture, and are identical with the texture of the early truck lands of the Atlantic Seaboard." In regard to the constituents of these soils, he says, "Typical truck soils of the Atlantic Seaboard contain from about 1 per cent. to 12 per cent. of clay in the sub-soil. The lighter soils, or those containing the least amount of clay, are better adapted to the earlier and lighter spring vegetables, while the heavier soils are better adapted to the later and heavier truck, and to those crops which can be planted in the fall for the early spring market. The conditions in a soil containing ten per cent. of clay in the sub-soil frequently delay the planting of a spring crop from two to three weeks later than on a soil containing only 5 per cent. of clay. Soils having over 10 or 12 per cent. of clay are too heavy and too retentive of moisture for the early truck crops. The yield per acre is larger than on the truck lands, but it has to meet more competition. The whole value of the truck soils lies in the relation of these soils to moisture, and in the relatively small amount of moisture they maintain for crops."

The samples below can be described as follows: Nos. 104 to 108 are composite samples from four localities 10 feet apart, taken from the virgin soil still uncleared. Different depths are represented from the surface to 6 inches deep down to 54 inches. No. 95 is the sub-soil (6–18 inches) from the cleared area in the roadway, as represented in the chemical analysis above. No. 99 is a sub soil from an uncleared virgin soil adjoining the locality from which No. 95 was taken.

MECHANICAL ANALYSES OF SOIL FROM THE FRUIT FARM, FROM THE SURFACE TO A DEPTH OF 54 INCHES.

No.	Depth. Inches.	Moisture.	Organic Matter.	Gravel 2—1 m.m.	Coarse Sand. 1—.5 m.m.	Medium Sand. .5—.25 m.m.	Fine Sand. .25—.1 m.m.	Very Fine Sand. .1—.05 m.m.	Silt. .05—.01 m.m.	Fine Silt. .01—.005 m.m.	Clay. .005—.0001 m.m.
		per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.
104	0—6	0.11	0.76	9.28	40.82	31.57	11.04	1.32	2.03	0.79	2.40
105	6—18	0.08	0.54	11.92	41.51	27.20	10.69	1.68	0.37	0.98	3.00
106	18—30	0.18	0.35	10.58	43.39	25.94	6.99	2.12	2.89	0.92	6.07
107	30—42	0.21	0.95	3.88	24.30	32.89	23.35	4.42	2.67	1.09	5.29
108	42—54	0.09	0.62	5.14	24.15	31.82	27.06	5.54	1.26	0.61	1.73
95	6—18	0.14	0.83	7.78	33.31	35.28	12.89	3.69	2.93	1.01	2.07
99	6—18	0.07	0.61	2.73	22.00	42.80	20.47	4.79	3.03	1.06	2.62

For the sake of comparison, several mechanical analyses of truck sub-soils, taken from the published reports of Prof. Whitney, are given below, and will prove of greater interest when later results in the vegetable field are described in subsequent reports.

MECHANICAL ANALYSES OF TRUCK SUB-SOILS.

LOCALITY.	Organic Matter.	Gravel 2—1 m.m.	Coarse Sand. 1—.5 m.m.	Medium Sand. .5—.25 m.m.	Fine Sand. .25—.1 m.m	Very fine Sand. .1—.05 m.m.	Silt. .05—.01 m.m.	Fine Silt. .01—.005 m.m.	Clay. .005—.001 m.m.
Florida, Altoona, High pine land	0.87	1.61	4.52	12.28	27.58	48.12	2.16	0.81	1.31
North Carolina, Newbern, early spring truck	0.67	0.00	0.30	6.04	49.63	32.39	6.24	1.93	2.80
Virginia, Norfolk	1.36	0.00	1.42	23.27	38.25	7.51	15.14	5.90	7.15
Maryland, West shore, Severn River	3.36	0.63	3.73	38.01	28.69	10.31	10.26	1.81	3.20
Maryland, East shore, Salisbury	0.91	0.85	6.29	38.11	36.66	9.77	4.53	0.94	1.76
New York, Jamaica, Long Island	2.25	9.59	19.06	24.91	9.65	10.08	14.10	3.29	7.25
Massachusetts, Boston	2.50	1.64	3.42	10.58	29.32	43.93	4.99	1.03	1.84

6. THE PLAN OF THE EXPERIMENTAL TESTS.

The general plan adopted for the fruit tests consists of a series of 29 plats of one-tenth acre each, for each variety tested, excepting the small fruits, the plats of which are 1-40 acre each. The series of fruits tested are:—

Series. *Fruits.*

I. Small fruits. *a.* Strawberries (planted in 1896.)
b. Blackberries.
c. Raspberries (planted in 1896.)

II. Grapes.
III. Peaches.
IV. Plums.
V. Pears (planted in 1896.)
VI. Apples (planted in 1896.)
VII. Chestnuts (planted in 1896.)

The plan of the series and plats can be seen by referring to the accompanying plan of the fruit department (Fig. 5). The dimen-

sions of each one-tenth acre plat are 49 ft. × 88.9 ft. The list of fruit is as comprehensive as possible. The fertilizing applications include the three main elements of plant food (phosphoric acid, nitrogen, and potash) in connection with an application of lime on some plats, and upon others the observation of the effect of leguminous crops. Phosphoric acid is applied as acid phosphate, either alone or in combination with potash and nitrogen, employing on different plats variations of the amount of these ingredients up to double and treble the amount. The same variation in potash, in the form of muriate of potash,* and nitrogen in nitrate soda, is observed.

The basis of the fertilizing applications is as follows:

Potash (*K*) equivalent to 50 lbs. of actual potash (K_2O) from muriate of potash,* per acre.

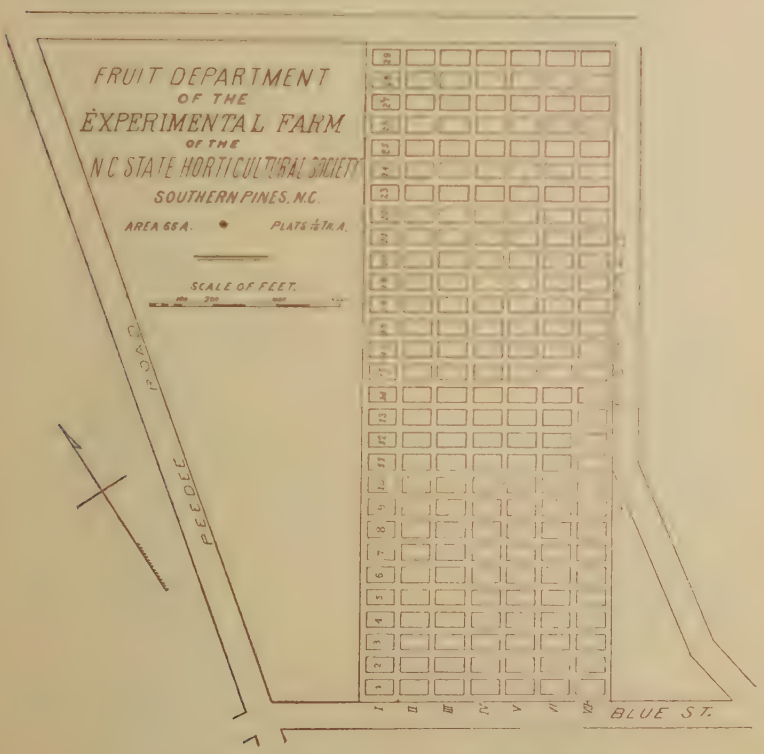

Fig. 5.—Plan of the fruit department, showing series and plats.

Phosphoric Acid (*P*) equivalent to 50 lbs. of available phosphoric acid in acid phosphate, per acre.

*For 1895, a part of the potash application on each plat was in the form of kainit, but for several reasons this plan was subsequently altered, so that after 1895 all of the potash applications are made with muriate of potash, except upon the plats testing the various potash salts.

Nitrogen (*N*) equivalent to 20 lbs. actual nitrogen in nitrate of soda, per acre.

Lime (*L*) equivalent to 2,000 pounds slaked lime per acre.

Green Manuring (*G*) or the growth of cow peas upon the plats, for the purpose of being plowed under to utilize for fertilizing purposes the nitrogen-gathering power of these legumes.

The design of these tests is to learn more particularly the relative quantity of plant food required for the proper development of the several trees and plants rather than to ascertain what form of fertilizing ingredient should be chosen to furnish the essential ingredients. Acid phosphate was selected because it is the more common source of phosphoric acid; nitrate of soda, because it furnished a readily available material with no other ingredient present to interfere with any interpretation of the results; muriate of potash, as it is a common source of potash. To some extent, nitrate of soda for the sole source of nitrogen, is objectionable, because of its ready solubility in the soil, but its other advantages more than compensate for this objection. The plan also embodies a comparison with the different forms of potash salts.

The actual analyses of the fertilizing materials used for the above purpose in 1895, were as follows:

Kainit	contained	11.98	per cent.	actual potash (K_2O).
Muriate potash	"	50.34	"	"
Sulphate potash	"	48.23	"	"
Acid phosphate	"	14.06	"	available phosphoric acid.
	"	11.09	"	soluble " "
	"	2.97	"	reverted " "
	"	1.24	"	insoluble " "
Nitrate soda	"	15.97	"	actual nitrogen.
Lime (slaked)	"	63.82	"	actual lime (C_3O).

The actual amount in grams of each of the special materials used to furnish 50 lbs. of potash; 50 lbs. of available phosphoric acid, and 20 lbs. nitrogen per acre, or five, five, and two lbs. respectively of these ingredients per plat, was as follows:

Kainit,	18,930	grams	per	1 10 acre plat	or	417.30	lbs. per acre.
Muriate potash,	4,505	"	"	"		99.30	" "
Sulphate potash,	4,702	"	"	"		103.60	" "
Acid phosphate,	16,130	"	"	"		355.60	" "
Nitrate soda,	5,674	"	"	"		125.20	" "

The following applications will show the amount of each ingredient per plant wherever such ingredient was used according to the plan of the experiments:

For Plums—

Kainit	315	grams	per tree.
Muriate potash	75	"	"
Sulphate potash	78	"	"
Acid phosphate	269	"	"
Nitrate soda	47	"	"

For Peaches—

Kainit	210	grams per tree.
Muriate potash	51	" "
Sulphate potash	52	" "
Acid phosphate	179	" "
Nitrate soda	31	" "

For Grapes (Delawares)—

Kainit	135	grams per vine.
Muriate potaah	32	" "
Sulphate potash	33	" "
Acid phosphate	115	" "
Nitrate soda	40	" "

For Grapes (Niagaras)—

Kainit	158	grams per vine.
Muriate potash	38	" "
Sulphate potash	39	" "
Acid phosphate	134	" "
Nitrate soda	47	" "

For Blackberries—

Kainit	382	grams per 10 plants.
Muriate potash	91	" "
Sulphate potash	95	" "
Acid phosphate	325	" "
Nitrate soda	114	" "

7. CLEARING THE LAND AND PREPARATION FOR PLANTING.

The clearing of the fruit tract was commenced February 18th, 1895. The appearance of the tract before this time can be seen by referring to Fig. 3, on page 8. The method adopted for this work was to carefully remove all trees after being felled, together with limbs, twigs, etc. The stumps remaining were dug out (Fig. 6) and hauled away. It was planned to treat all trees in this way, but it was found that the labor involved in digging out the stumps of the larger pines was too great, and they were accordingly burned *in situ*, and the ashes carefully removed. There were an average of five of these stumps upon each acre, but the careful removal of the ashes left no disturbing influence, which might have been caused if they had been left upon the land. The labor and expense of hauling trees and underbrush from the tract was very great, but it was necessary that no material that might furnish fertilizing ingredients should remain upon the soil. This would have been caused if brush, logs, etc., had been burned, as is generally done in the clearing of such lands for practical fruit culture. After the clearing was concluded, which was done as rapidly as possible, the work of preparation for planting was commenced. This consisted in plowing, with heavy turning plows, to a depth of eight to ten inches and upturning the compact sods of wire grass. All roots or trash turned up by the plows were gathered and carefully hauled from the field. A second plowing was contemplated across the first, but experience had proven

that this retards rather than aids the decomposition of the sods of the wiregrass, which are very tough and with difficulty cut by the plow. The breaking plows were followed by harrows (Fig. 7) going twice in opposite directions, and the surface reduced to as fine a condition as possible. The harrows used were the "Acme" and the "Spring-Tooth." The former gave rather better satisfaction. Such was the rapidity with which the clearing progressed, that barely four

Fig. 6.—Digging out the stumps of trees in clearing the Experimental Farm.

weeks later (Fig. 8) the land was in a condition for laying off the plats previous to planting.

8. VARIETIES OF FRUIT SELECTED, AND GENERAL TREATMENT.

The kinds of fruits selected for the experiments were such as promised to yield the greatest profit upon this soil. They were the peach, plum, apple, pear, grape, blackberry, raspberry, strawberry, and Japanese chestnut. The varieties of each kind of the above named fruit selected were such as experience had shown will succeed upon sandy soils, that yield their product early, and that appear well when shipped to market. The following is the list:

1. Strawberries—Lady Thompson. (Not planted in 1895.)
2. Raspberries—Cuthbert. (Not planted in 1895.)
3. Blackberries—Early Wilson. (One year old plants from root cuttings.)
4. Grapes—Niagara and Delaware. (One year old.)
5. Peaches—Elberta. (June buds.)
6. Plums—Abundance, Burbank, Maru, Ogon, Pool's Pride and Wayland. (One year old.)
7. Pears—Kieffer. (Not planted in 1895.)
8. Apples—McCullers' Winter. (Not planted in 1895.)
9. Chestnuts—Japanese Mammoth, imported. (Not planted in 1895.)

Two varieties of grapes were planted upon each of the ¼ acre plats, in order to test the two leading types of the better class of shipping grapes. This allowed ⅛ acre for each variety and for each fertilizing application. The six varieties of plums were selected for the purpose of cross fertilization, there being two trees of each variety upon each plat. Of the above the peach, the plums, grapes and blackberries were planted early in April, that being the earliest time the ground could be put in proper condition for planting, and the trees and vines could be procured. The seasons were very unpropitious, as can be seen from the meteorological records elsewhere shown, and it is believed that the late planting, which was unavoidable, coupled with the poor seasons, affected disadvantageously the growth of the trees and blackberries, though the vines did not seem to be thus hurt.

(Fig. 7.—Harrowing the Experimental Farm previous to planting.)

It was determined, owing to the late preparation, to defer the planting of the apples, pears, chestnuts, raspberries and strawberries to the following winter and spring.

After planting, all the trees were pruned to a uniform height of 18 to 20 inches, to ensure low heads. Experience has shown that on such soil in this latitude, high-headed trees are much affected by "sun-scald." The aim of future pruning will be to keep a round, open-headed tree, with fruiting wood well distributed throughout, so that the load of fruit may be evenly balanced. Blackberries and

raspberries will be pinched at a height of about three feet to induce a bushy habit to reduce the work of tying, as well as to protect the stems from sun-scald. The grapes will be trained on the Munson three-wire trellis, the wires being four feet from the ground. The spur renewal system of pruning will be followed. The strawberries will be grown by the hill system, as being more easily compared, and the relative yield better determined.

In all cases, shallow, clean cultivation will be given from March 1st till August 1st. Some of the plats of each series will be sown with a leguminous crop, which latter will be turned under to supply humus and nitrogen for the successive fruit crops.

Fig. 8.—Appearance of The Experimental Farm after four weeks of clearing. (See figure 3, page 8, for the appearance of the land before clearing.)

The crop will be carefully graded and, excepting a sufficient portion retained for analyses, will be shipped to the most promising markets, where they will be sold upon their merits.

9. LAYING OUT PLATS, SETTING PLANTS, AND SUBSEQUENT CULTIVATION.

As it is endeavored that every step in the progress of the work should be done with mathematical accuracy, the plats were laid out with a surveyor's transit. Each plat is one-tenth acre, being a rectangle 49 feet wide and 88 9 feet long, the long sides extending in an easterly and westerly direction. Stakes two inches square were located at each corner, and painted white with the number of the plat upon the two inner sides of each. A roadway of 20 feet be-

tween each series and between each plat was left for convenience of access and to separate completely the several plats. In setting out the vines and trees the same accuracy was observed. It was desired that the distance between rows should be approximately as follows:

Plums, 20x20, equivalent to 108 per acre.
Peaches, 16x16, equivalent to 170 per acre.
Grapes, 1. Niagara, 8x10, equivalent to 554 per acre.
" 2. Delaware, 6x10, equivalent to 726 per acre.
Blackberries, 3x6, equivalent to 2,420 per acre.

The actual dimensions, however, between each row and plant proved to be as follows, it being of course understood that the odd number of feet between trees and plant is due to the necessity of having a definite number of plants upon each plat:

Plums—3 rows to the 1-10th acre plat and 4 in a row, or 12 to the plat, or 120 to the acre. The rows are 16.33 feet apart, and 8.16 feet from roadway on the side of plat. The trees are 22.22 feet apart in the rows, and 11.11 feet from the roadway.

Peaches—3 rows to the plat, and six in a row, or 18 to the plat, and 180 to the acre. The rows are 16.33 feet apart, and 8.16 feet from the roadway. The trees are 14.51 feet apart in the rows and 7.40 feet from the roadway.

Grapes—On the 1-10th acre plat were two varieties upon 1-20th acre each, as follows:

1. Niagara—which are on the western side of the plat—contained 5 rows and 6 to the row, or 30 to the plat, or 600 to the acre. The rows are 9.8 feet apart and 4.9 feet from the roadway, with vines 7.41 feet in the row and 3.70 feet from the roadway.

2. Delaware—on the eastern side of the plat—with 5 rows and 7 in the row, or 35 to the plat, or 700 to the acre. The rows are 9.8 feet apart and 4.9 feet from the roadway, with vines 6.35 feet apart in rows, and 3.17 feet from the roadway.

Blackberries—8 rows to the plat and 31 plants to the row, or 248 to the plat, or 2,480 to the acre. The rows are 6.12 feet apart and 3.06 feet from the roadway, with the plants 2.87 feet apart, and 1.43 feet from roadway.

The manner of locating the trees and plants was as follows: A No. 10 galvanized iron wire was used as a planting line, with the distance for locating the trees in the row being carefully measured upon the wire. This was stretched very tight, by stakes driven at either end of the wire, and furnished an invariable measure for locating the trees. The present appearance of the trees, in mathematically exact rows, shows the accuracy of this plan.

The Plums were set out April 4th and 5th. There had been no rain during the week, and the ground was quite dry. The roots of all, after being cut back to six inches and evenly balanced, as near as possible, were "puddled" by dipping in a barrel of water, and then while wet were covered with soil. The trees, after planting, were headed to a uniform head of eighteen inches. The first tree

set out on the Experimental Farm was an Abundance Plum, on April 4th, 1895, at 12 M., (Fig. 9) in the presence of H. L. Thurston, B. von Herff, D. D. F. Cameron, B. W. Kilgore, H. B. Battle, and two laborers.

It is hoped that the name of the plum will be typical of the beneficial results to accrue from the experimental work.

The Peaches were next set out, on April 6th, and in the same manner as the plums. The Grapes were planted on April 9th, during which time a beneficial rain fell. The vines were cut to two buds, and were 4 to 6 inches high. The roots were left from 8 to 12 inches in length Stakes about six feet long were subsequently driven beside each vine, to which the shoots were tied as they grew. The stakes will give place to a wire trellis the second year.

Fig. 9.—Planting the first fruit tree on the Experimental Farm, April 4th, 1895.

The Blackberries were planted on April 9-10, though the last eight series were planted later, on the 23d. The plants were cut back to 2 to 4 buds and the same height as the grapes. The roots were pruned to 6 and 8 inches. In order to protect the plants from the effect of the very hot sun, a mulching of long-leaf pine straw (Fig. 10) was placed upon each plat at the rate of one one-horse load, averaging 165 lbs. per plat. This was done on April 24th and 25th.

The cultivation of the plat after planting was shallow, so that no damage to the root systems could result. The implements used for the purpose were the Iron Age and Planet Jr. one-horse cultivators. The treatment was repeated at intervals of ten to thirteen days, as the condition of the soil demanded it, until August 1st. No weeds appeared in any of the plats, except a few Euphorbias and fire-weeds

(Erechtites), but shoots from the roots of the oaks originally upon the land gave some trouble.

On June 15th, the plats designed to test the effect of leguminous crops, were sown in cow-peas, broadcast, at the rate of 75 lbs. per acre, (equivalent to 1¼ bushels). The variety sown was the "Unknown," or "Wonderful," which was selected because of its very vigorous growth of vine. The growth of the peas were left on the plat all to be turned under the following winter or spring, at which time lime will be applied upon the plats allotted to it In future,

Fig. 10.—Appearance of the Blackberry series mulched with pine straw. The foreground shows recently plowed ground.

the peas will be sown in drills between the plants, instead of broadcast, as it was ascertained that the pea vines in the latter case proved objectionable by interfering with the proper growth of the plants.

10. DETAILS OF FERTILIZING.

The contents of the bags of fertilizing ingredients were mixed very thoroughly on a clean wooden floor, the few lumps found being carefully pulverized and well incorporated. An accurate sample was taken for analysis. The manner of mixing the ingredients and of slaking the lime can be seen in Fig. 11. The amounts of the different ingredients were carefully calculated for separate applications upon each of the plums, peach, and grapes, the purpose being for each tree and vine to receive separate portions of each ingredient, which were to be carefully applied by hand to ensure accuracy (Fig. 12), so that the exact amount of materials should be applied where

intended. The materials for each tree and vine were mixed in paper bags, and carried upon trays and deposited upon the plats to be fertilized. For the blackberry series the weighings were made for each row, instead of each tree as in the other series.

Fig. 11.—Slaking lime preparatory to applying.

As the trees, vines, and plants were in their first year of growth after transplanting from the nurseries, the applications of the different fertilizers, instead of being full normal amounts as stated below, were divided into the following proportionate parts, and the applications were made at the time stated. And as their roots would not extend to a great distance during the first year, the application was made only upon the probable area that would be reached by them.

For the Plums and Peaches.—One-fifth of the normal amount of potash and phosphoric acid was applied at the time of planting, and one-fifth of the normal amount of nitrogen was applied (one-half at time of planting, and the remaining one-half during the first week in June). The fertilizers were applied in a circle of 3 ft. radius surrounding each tree, excepting the first application of nitrogen, which was upon a circle of one foot radius.

For Grapes.—One-half of the normal amount of potash and phosphoric acid was applied at time of planting, and one-half of the normal amount of nitrogen, one half of which ($\frac{1}{4}$ of normal) was applied at planting, and the remaining one-half during the last week in May. The applications were made upon one-half the whole area, or in other words, it was expected that the roots from each row would reach one-fourth the distance in each direction. The first applica-

tion of nitrogen here was upon a circle of 12 inch radius surrounding the vine.

For the Blackberries.—One-half the normal amount of potash and phosphoric acid was applied at time of planting, and one-half of the normal amount of nitrogen, one-half of which (or ¼ of normal) was applied at time of bursting of buds, the remaining one-half one month later. The applications were made upon the whole area of the plat, except that the first application of nitrogen was upon one-half of the area.

For 1896 and thereafter, the amount of applications, as well as the area fertilized, will be increased according to the age of the several trees and vines. In making the applications, the different ingredients were taken from the bags already carried to the plats,

Fig. 12.—Manner of applying fertilizers to each tree to ensure accuracy.

carefully applied and worked in as a top dressing around the trees and vines to the distance named above, in order that the roots in growing might have access to the plant food in these materials as their needs would demand.

The labor involved in weighing out the portions and applying in the manner stated was very great, the total number of these weighings being 6,556.

The portion of the work relating to the fertilizers was done entirely by experienced men from the chemical division of the Experiment Station.

Plan of the Fertilizing Applications upon the Plats during 1895.

The fertilizing applications upon each of the $\frac{1}{10}$ acre plats are as follows, in which K, P, N, G, and L represent the fertilizing ingredients stated below, there being two plats (8 and 21) with no fertilization thereon left for comparison:

K represents 50 lbs. actual potash (K_2O) per acre, from muriate potash, except that sulphate of potash is used on plat No. 29.
P represents 50 lbs. available phosphoric acid per acre, from acid phosphate.
N represents 20 lbs actual nitrogen per acre, from nitrate soda.
G represents green manuring with cow-peas.
L represents 2000 lbs. slaked lime per acre.

Class 1.—Single Ingredients and Combinations.

Plats No ...	*1	2	3	4	5	6
Applications	K	P	N	KP	KN	PN

Class 2.—Three Ingredients in Variable Amounts.

Plats No ...	7	8	9	10	11	12	13	14	15
Applications	KPN	O	$K\frac{1}{2}PN$	K_2PN	K_3PN	$KP\frac{1}{2}N$	KP_2N	KP_3N	$KPN\frac{1}{2}$
	16	17							
	KPN_2	KPN_3							

Class 3.—Standard Application (K_2PN) and Substituting Green Manuring and Lime for Nitrogen.

Plats No	18	19	20	21	22	23
Applications	$(K_2P)G$	$2(K_2P)G$	$2(K_2P)NG$	O	K_2PNL	$(K_2P)LG$

Class 4.—Multiples of the Standard Application (K_2PN) with Green Manuring and Lime.

Plats No	24	25	26	27	28	29
Applications	$\frac{1}{2}(K_2PN)GL$	$(K_2PN)GL$	$2(K_2PN)GL$	$3(K_2PN)GL$	$4(K_2PN)GL$	K_2PN

Fertilizers Applied to the Plats in Approximate Amounts.

In order to present, in a condensed shape, the normal applications *per acre* upon each plat, they are given below in approximate amounts for convenience of comparison (the exact amounts depending upon the analysis of the ingredients). The figures refer to pounds.

* After 1895 the first three plats were changed to test the three forms of potash, as given in the following table. Also muriate of potash after 1895, is the entire source of potash in all of the other plats, except No. 29.

Fertilizers Applied to the Plats in Approximate Amounts in Pounds after 1895.*

Plats.	Muriate potash.	Acid phosphate.	Nitrate soda.	Kainit.	Sulphate potash-magnesia.	Carbonate potash-magnesia.	Sulphate potash.	Slaked lime.	Green manuring.	Plats.
1	.....	400	125	800						1
2	.....	400	125	.....	400					2
3	.....	400	125	.....	.....	600				3
4	100	400	.....							4
5	100	.....	125							5
6	.....	400	125							6
7	100	400	125							7
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
9	50	400	125							9
10	200	400	125							10
11	300	400	125							11
12	100	200	125							12
13	100	800	125							13
14	100	1,200	125							14
15	100	400	63							15
16	100	400	250							16
17	100	400	375							17
18	200	400	.....						GM	18
19	400	800	.....						GM	19
20	400	800	125						GM	20
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
22	200	400	125					2,000		22
23	200	400	.....					2,000	GM	23
24	100	200	63					2,000	GM	24
25	200	400	125					2,000	GM	25
26	400	800	250					2,000	GM	26
27	600	1,200	375					2,000	GM	27
28	800	1,600	500					2,000	GM	28
29	.....	400	125	.....	.....	.....	200	.....	.....	29

*During 1895, plats 1, 2 and 3 had only K, P, and N, respectively.

The fertilizers, as above stated, were applied to the plats on April 12–16. The second application of nitrate of soda was made June 14–15.

As has been stated, a mulching of pine straw was placed on the blackberries at the average rate of 165 pounds per plat. The composition of the straw on the air-dried sample was as follows:

Phosphoric acid	0.120 per cent.
Nitrogen	0.325 " "
Potash	0.031 " "

This mulch for the quantity stated added to each plat the following:

Phosphoric acid	0.198 pounds.
Nitrogen	0.536 "
Potash	0.051 "

These quantities in themselves were very small, but even if appreciable, they were added uniformly to each plat, and consequently may be omitted from subsequent consideration of the relative applications.

The application of lime was made April 24th on plats Nos. 22 and 23. It consisted of 200 pounds slaked lime per plat. This slaked lime was made with building lime, slaked with water to a powder. Four barrels of lime of about 190 pounds each, or 760 pounds, slaked to 1,372 pounds. The application of lime upon Nos. 24, 25, 26, 27 and 28 were reserved till the peas upon them were plowed under.

II. METHODS OF RECORDING GROWTH, MAKING NOTES, AND SECURING PHOTOGRAPHIC RECORDS.

To make the work of the greatest value, it was decided that complete notes should be taken of the progress of the growth of the various series, and to more surely note the effect of the different applications and their treatment upon the several plats. During 1895, the condition of the plants on the different plats were noted very carefully and with much detail three times during the season, namely, June 1–3, August 9–12, and November 6–9. In the record, each plant of the peach and plum plats is treated individually, but for vines on the grape plats only every second plant in each alternate row was noted, except where intermediate plants were dead or missing, when the fact was also recorded.

At the first examination, June 1st, the following facts were recorded: 1. Plant number in plat; 2. Height pruned at planting; 3. Length of new growth; 4. Insect damages; 5. Fungous damages; 6. General remarks. At the second examination, August 9–12, the following facts, regarding each plant, was noted: 1. Plant number; 2. Average new growth of shoots in inches; 3. Number of shoots; 4. General vigor of plants; 5. Insect damages; 6. Fungous damages; 7. General remarks. At the third examination, November 6th, the following facts were recorded of each plant: 1. Plant number; 2. General appearance; 3. Condition of winter buds; 4. Condition of bark; 5. Color and condition of foliage; 6. Average length of new shoots; 7. Number of new shoots per tree; 8. Remarks.

For the year 1896 and afterwards, much more comprehensive records will be kept, embracing the life of the trees and plants upon the plats from planting to the matured fruit, as well as the appearance thereafter.

In connection with a record of the growth of the trees, vines, and plants by the means of notes and observations, it was determined to preserve full records by means of photographs, in order that a visible demonstration might be preserved of the actual growth upon each plat at stated intervals during the year. The collection of photographs taken include 159 subjects, and embrace every detail, from the beginning, when the fruit tract was located, to the end of the year 1895. During this time each plat of each series was photographed, with the exception of the blackberries. Among other photographs, is shown the appearance of the pine forest before work was commenced, and when it was still in its natural condition; also the

felling of trees, the digging of stumps, the hauling off of logs upon log wagons, the removal of trees, roots, brush and undergrowth; the first plowing of the soil, harrowing, laying off plats with the transit, the planting of the different series, the mixing of fertilizers, carrying the fertilizers in paper bags to the various plats, the application of these fertilizers. These were followed by the general appearance of the different series viewed from the avenue. Later on, upon August 4th and 5th, views of the appearance of each plat of each series were made in detail.

12. WEATHER CONDITIONS DURING 1895.

No observations were taken at the immediate locality of the tests, but the records of the observing station, cooperating with the Experiment Station, at Southern Pines, are available and are inserted below. The instruments are located about two miles from the experimental fields, and present a fair statement of the weather conditions at the latter points. It should be stated, however, that there has been some slight interruption in these records, and they cannot be given in full in every respect.

WEATHER CONDITIONS DURING 1895.

	Jan.	Feb.	Mar.	Apr.	May	Ju.	Jul.	Aug.	Sept	Oct.	Nov.	Dec.	Year.
Average Monthly Temperature	40.3	34.8	51.6	59.8	67.0	77.6	78.2	79.	78.7	61.8	54.6	47.5	60.9
Precipitation	7.60	2.39	8.78	6.83	2.07	4.79	4.93	5.99	0.11	1.87	...	3.54	
No. clear days	15	17	17	16	18	18	20	19	...	22	17	22	
No. partly cloudy days.	7	2	2	5	6	6	7	7	...	7	11	6	
No. cloudy days.	9	9	12	9	7	6	4	5	...	2	2	3	
No. rainy days.	8	7	11	15	10	13	12	10	1	2	...	4	

DEPARTURES FROM THE NORMAL MONTHLY TEMPERATURE AND PRECIPITATION.

The variation from the normal monthly precipitation and temperature can be seen below, and are determined by comparing the above table with the discussion of the climatic conditions of Southern Pines, on pp. 13, 15:

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Temperature.	—1.7	—11.2	+1.6	— 1.2	+ 2.0	+1.6	—0.8	+ 3.0	+ 8.7	+ 2.8	+ 3.6	+ 2.5
Precipitation.	+2.90	—1.64	+4.44	+3.69	—2.65	+0.49	—1.51	+0.42	—3.35	—1.49	...	+0.51

The most noteworthy facts during the year, were the low temperatures during January, February and April, and the high temperatures of August to December. The precipitation was greatly above the normal in March and April, and below in the months of September and October.

13. FUNGOUS AND INSECT ENEMIES AND THEIR TREATMENT.

Newly-planted orchards in regions sparsely settled are not, as a rule, greatly troubled by insect or fungous pests for some years after planting. In the case of the present experimental work, the rule held good except as to a species of native ant, (*Solenopsis geminatus, Fabr.*), which is a very common occupant of the virgin soil on these pine lands. The removal of the forest growth appears to cut off the normal food supply of these insects, and as a consequence they attacked the young and tender shoots of the peach and plum trees with a voracity that seriously threatened the lives of the plants. The grape vines, for some unknown reason, were almost exempt from their attack. To prevent the ravages of these insects, several plans were tried on May 27th to June 3d upon a portion of the peach and plum trees. On each plat was applied a three-inch band of ordinary whitewash, to each five gallons of which was added one gallon of cotton-seed oil. This is a popular remedy for orchard-infesting ants in Georgia, except that engine oil is used in place of cotton-seed oil. The whitewash, however, soon dried completely, and the ants had no difficulty in passing over it, while the oil in the wash seemed to injuriously affect the tree. It is possible that if the engine oil had been used, the remedy might have proven more successful. Another remedy was tried by applying a ring of loose cotton lint near the base of the tree and tied with a string sufficiently tight to prevent the ants from passing between the lint and the bark. For some days this proved an effectual barrier to the ants, but after a few hard rains the filaments of the lint became matted together, and they passed over with more or less difficulty, and in numbers sufficient to do considerable damage. On July 10th, both these methods were discarded and the bands removed from the trees. A few thicknesses of manila wrapping paper were next wound around the base of the trees to a height of three inches, and upon this was painted a thick band of "Ermisch's Insect Lime," a patented commercial article, sold at about 15 cents per pound. This is a thick oily substance, much resembling axle grease, and is, doubtless, a product of petroleum. It has been used to a considerable extent by the Massachusetts Gypsy Moth Commission in its warfare against that pest. For about two weeks the greasy viscid, band remained an unsurmountable barrier to the ants, then it began to harden on the outside and the ants were again able to pass over and resume their destructive work upon the foliage. The trees were next sprayed with the standard Bor-

deaux Mixture, consisting of 4 pounds copper sulphate, 4 pounds stone lime to one barrel of water. To each barrel of this was added 4 ounces of Paris Green. It was applied with a Garfield Knapsack Sprayer, fitted with the Vermorel nozzle. This proved a satisfactory remedy for the ants, as long as it covered the foliage, but the rains soon washed it off and the new shoots developed new leaves, and after about ten days the ants, how much decreased in numbers, were back on the trees. On August 15th, the plats were again sprayed. This time, to make the liquid adhere better to the foliage, one gallon of black molasses was stirred into the mixture, which otherwise was the same as before, except that only three ounces of Paris Green was added to the barrel. This was applied as before with a knapsack sprayer and the mixture was kept properly stirred. No injury to foliage resulted, and the liquid remained on the leaves till they fell in November. The ants, however, still continued to do more or less damage, and none of the methods employed against them can be called a complete success. Our experience seems to show that early and persistent spraying with Paris Green, not to exceed three ounces to fifty gallons of Bordeaux mixture, combined with continuous stirring of the ground, will kill or drive the ants away. We found the addition of one gallon of black molasses an improvement to the ordinary Bordeaux mixture, making it adhere much longer to the foliage. Besides these ants, no other insect of any importance was seen upon the plants.

The only fungous diseases noticed, was the microscopic fungus "Shothole" (*Septoria persicæ*) of the leaves of the peach trees, and to a much lesser extent, the "Shothole" fungus of the plum, and the downy mildew on the leaves of the grape vines. Mildew attacked chiefly, and to a very considerable degree, the Niagara, and to a very much lesser extent the Delaware vines.

Grape mildew was held in check fairly well by the Bordeaux spray, applied only twice during the summer. The treatment should have been repeated four times, and would probably have greatly reduced the spread of this fungus, which, however, did no appreciable damage. The *Septoria*, however, was much more stubborn. The first application of Bordeaux mixture had only a slight influence in checking it, probably because it was washed off so quickly. The second treatment, which adhered well to the foliage, practically prevented further spread of the fungus. No other fungi of any economic importance was noted.

14. DIFFICULTIES ENCOUNTERED DURING THE FIRST YEAR.

It should be stated that several difficulties presented themselves during the prosecution of the work during 1895. Several of these proved serious and materially affected the general character of the results. They can be enumerated as follows:

1. Fresh Land.—Experience has proven that for most fruit crops, it is not desirable that fresh land should be used for planting. The soil is permeated by the lateral roots of the pines, oaks, and undergrowth and of the heavy growth of the wiregrass. The latter, especially, on account of its hard compact sod, and difficulty in pulverizing it, and its slow decomposition, prevents the soil particles from adhering to each other, and leaves numerous air spaces of greater or less dimensions below the surface of the soil, even after repeated harrowings. The mechanical difficulty thus presented by the undecomposed sod and the air spaces between them, to the passage of the fine tender roots of the newly planted trees, were numerous causes for the lack of growth. The organic matter of these materials, and the acidity of the soil produced by the decomposition throughout the season, doubtless had an injurious effect upon the roots of the stock, and injuriously affected its growth.

2. Late Planting.—The process of clearing the land necessarily required time, owing to the care required to ensure the best results, as well as because such a large area had to be cleared. With all the available force, amounting to twenty men and three or four teams, it was not possible to prepare the land for planting before the first week in April, the work having been begun just after the middle of February. Ordinarily this would have been almost too late for setting out the trees and plants.

3. Bad Weather Conditions.—The spring season, as well as the late winter season, although very exceptional in the amount of precipitation and the departure from the normal mean temperature, proved rather advantageous than otherwise, for it allowed additional time for the clearing, and prevented spring growth for two or three weeks later than usual. At the time the stock was set out most of it was budding. This would not have been a serious objection but for the advent of the warm spring weather so long delayed. The heat proved too great for many of the plants, and they showed lack of vigor from the start, causing some soon thereafter to fail and die The peaches and blackberries especially showed this result; the plums less so, and the grapes least.

4. Nursery Stock.—Owing to the extent of the work of preparation, the choicest nursery stock could not be secured, and the failure of some of it, especially the blackberries, may be attributed to this cause.

15. GROWTH DURING 1895, AND CONCLUSIONS.

As has been stated, the blackberries, peaches, plums, and grapes in the order named, were injuriously affected by the abnormal conditions of bad seasons, fresh ground, and other causes already named. The blackberries were so hurt that soon it became apparent that the results could not be accurate, and that new planting would be necessary. It was, therefore, decided that the whole series should be replanted for the year 1896.

Fig. 13.—Plat No. 10 of the Peach series with K_2PN fertilizer.

The peaches were also badly hurt by the abnormal weather conditions and especially by the fresh land, and ant depredations. A large majority of the trees soon succumbed to these adverse conditions. Two cuts are here appended showing the beneficial effects of

Fig. 14.—Plat No. 22 of the Peach series. Same fertilizer as Fig. 13, with the addition of lime.

lime upon fresh land in the peach series, though the lime application could be traced in the same way upon the other series of plums and grapes. Plat No. 10 of the peaches (Fig. 13) has the K_2 P N application. Only four of the eighteen trees upon the plat were living at the time of the photograph on August 24th, and these were in a thriftless condition. When this plat is contrasted with plat No. 22 upon which the same fertilizing application was used with the addition of slaked lime (Fig. 14), the improvement is at once apparent. The latter by its action upon the soil has corrected the effect of organic decomposition, and has left the soil in a more normal state. The result is that fifteen of the eighteen trees of the plat are living and in a flourishing condition. The photographs were taken at the same time. The white measuring rod in the cuts is four feet high. At the end of the growing season, owing to unsatisfactory conditions of most of the peach trees, it was determined to replant all the trees of this series, using one-year old trees for this purpose. Observations were taken of the growth of the trees of this series during 1895, but the results, owing to the very incomplete stand, are not included.

The trees of the plum series were not injured as much as those of the peach series, but were far from being a first-class stand. Two cuts are appended showing the normal application of K_2PN on plat No. 7 (Fig. 15), and the appearance of plat No. 8, which had no fertilizer upon it (Fig. 16). Observations of the growth of the trees of the plum series were carefully taken, and are here appended on p. 40. The average growth is made by recording the measurements of the living trees upon the plats, and combining the growth of the six varieties in these averages.

So many adverse conditions occurred during the first year of growth that conclusions upon the plum series can be but meagre and untrustworthy, and are here omitted.

The grape series presented a much more even growth, and the appearance of the various plats were much more satisfactory. Several cuts are here shown illustrating the growth of some of the representative plats, the photographs being taken at the same time (August 23, 1895). The measuring rod is seven feet in height. The first three plats of the series, with single applications of potash (K), phosphoric acid (P) and nitrogen (N) (Figs. 17, 18 and 19) show results but little better than on plat No. 8 with no fertilization (Fig. 20). A combination of the ingredients K, P, and N (Fig. 21) show a very decided improvement over the single ingredient plats. The three next cuts (Figs. 22, 23 and 24) show the effect of a larger amount of each of the three ingredients in combination, namely K_2 PN (in Fig. 22) KP_2N (in Fig. 23) and KPN_2 (in Fig. 24). The result in each case is very striking, but the greatest increase in growth is where the larger amount of nitrogen has been applied. The winter prunings will give a better idea of the comparative results of the various fertilizers than does the average growth upon the several plats. The wood was cut back to six inches from the ground

Fig. 15.—Plum series. Plat No. 7, Fertilizer application of KPN.

or to the original height at the beginning of the season, and the air-dry weight of these prunings is shown in the table on p. 42, together with the average growth on the several plats on June 8, August 12

Fig. 16.—Plum series. Plat 8, with no fertilizer.

and November 6. The winter prunings, therefore, include the entire growth of shoots for the year, no other pruning having been made during the season of growth. The weight of winter prunings in the following table are calculated to a full stand of vines from the actual weight of the vines living at the time of pruning.

Average Growth in Inches of the Plum Series During 1895.
(Trees were set out April 5, 1895.)

Plat and Fertilizer.	June 7.	Aug. 12.	Nov. 6.
1. K	7	8	11
2. P	6	7	11
3. N	7	9	14
4. KP	6	7	9
5. KN	7	10	17
6. PN	9	14	24
7. KPN	7	12	23
8. O	5	5	6
9. K½PN	7	10	18
10. K_2PN	6	8	15
11. K_3PN	7	10	16
12. KP½N	7	10	20
13. KP_2N	5	10	17
14. KP_3N	--	10	16
15. KPN½	4	6	15
16. KPN_2	4	7	18
17. KPN_3	5	5	10
18. K_2PG	3	4	6
19. $2(K_2P)G$	4	4	4
20. $2(K_2P)NG$	6	11	12
21. O	5	5	8
22. K_2PNL	7	9	23
23. K_2PLG	4	4	4
24. ½$(K_2PN)GL$	6	9	10
25. $(K_2PN)GL$	5	9	11
26. $2(K_2PN)GL$	4	7	11
27. $3(K_2PN)GL$	4	4	20
28. $4(K_2PN)GL$	5	7	22
29. K_2PN (sulphate)	7	13	24

As has been previously stated, the growth of the cow-pea vines upon plats 23 to 28 inclusive, appears to have injuriously affected the growth of the grape vines. This was due to planting the peas broadcast and too near the vines. The same result was also noticed upon the peach and plum series. Hereafter the peas will be planted either in rows or in narrow bands at sufficient distances from the rows of trees and vines to prevent any probable injury.

It is not desirable to draw many conclusions from the results of growth shown in the table above, and these should be stated with caution. It appears too that the field is not as uniform as the general characteristics would indicate, and that the natural fertility of the soil is least at the southern end, at the beginning of the series, but that the upper two thirds is more uniform. It is expected, however, that this variation will be overcome by subsequent cultivation

Fig. 17.—Grape series. Plat 1, with K fertilizer.

in after years. It is evident that the following conclusions can safely be drawn: (1) That a very large increase of growth is caused by the application of fertilizers properly compounded, although it cannot be

Fig. 18.—Grape series. Plat 2, with P fertilizer.

Average Growth in Inches of the Grape Series during 1895, and the Weight of Winter Prunings in Grams. Vines were set out April 9, 1895.

Plat and Fertilizer.	Niagaras.				Delawares.			
	June 8.	Aug. 12.	Nov. 6.	Weight of winter pruning.	June 8.	Aug. 12.	Nov. 6.	Weight of winter pruning.
1. K	11	19	37	196	8	13	14	79
2. P	15	20	31	246	10	18	18	136
3. N	14	18	24	140	10	14	12	89
4. KP	13	18	27	156	7	15	16	112
5. KN	15	26	35	286	8	12	13	90
6. PN	12	18	27	234	8	12	17	116
7. KPN	11	16	20	172	8	13	17	131
8. O	10	12	16	111	7	7	7	36
9. K½PN	16	25	37	382	9	14	21	209
10. K_2PN	15	35	43	537	9	17	26	244
11. K_3PN	15	41	50	945	9	22	23	296
12. KP½N	13	29	61	810	9	26	37	629
13. KP_2N	16	43	59	1085	8	31	42	494
14. KP_3N	15	43	59	1275	7	25	34	734
15. KPN½	16	32	55	676	8	24	25	249
16. KPN_2	16	40	61	1379	8	26	36	603
17. KPN_3	13	42	52	1212	10	28	44	831
18. $(K_2P)G$	17	26	33	369	10	12	28	232
19. $2(K_2P)G$	12	20	29	167	8	13	18	125
20. $2(K_2P)NG$	16	36	36	518	9	21	28	344
21. O	12	25	33	322	10	18	24	245
22. K_2PNL	20	45	56	1277	9	29	48	732
23. K_2PLG	11	18	14	190	9	18	13	134
24. ½$(K_2PN)GL$	16	30	37	386	7	13	23	175
25. $(K_2PN)GL$	14	26	38	408	7	21	19	137
26. $2(K_2PN)GL$	16	37	44	696	9	20	26	212
27. $3(K_2PN)GL$	12	35	46	622	8	27	26	402
28. $4(K_2PN)GL$	11	29	37	640	6	21	20	273
29. K_2PN (sulphate)	13	45	69	1099	12	34	45	752

definitely stated with only the result of one-season's growth what is the best proportion; (2) that lime in connection with the complete application of the three ingredients very greatly increased the vine growth, and that this effect is probably due to a great degree to the beneficial action of the lime upon the fresh soil by aiding in the decomposition of organic matter, and thus neutralizing the effect of organic acids produced; (3) the use of the sulphate as a source of potash appears to be of greater value than the muriate; whether this result is due to the fact that the sulphate more than muriate can be more easily taken up by the vine in the process of growth, or that the sulphate has acted chemically upon the soil to render more available the compounds already present, is not altogether apparent, but it is likely that both causes have been effective; (4) that the broadcast sowing of cow peas for green manuring on fruit crops near the vines and trees is not to be commended, but that a suffi-

Fig. 19.—Grape series. Plat 3, with N fertilizer.

Fig. 20.—Grape series. Plat 8, with no fertilization.

Fig. 21.—Grape series. Plat 7, with all three ingredients, KPN.

cient open space should be left between them so as to prevent any interference of the growth of the fruit crops.

The conclusions which might be drawn from the application of the various fertilizing ingredients, or due to other causes, might

Fig. 22.—Grape series. Plat 10, with K_2PN application.

Fig. 23.—Grape series. Plat 13, with KP_2N application.

easily be extended and elaborated, but it is believed that it is preferable to await further results before more decided statements are ventured.

Fig. 24.—Grape series. Plat 16, with KPN_2 application.